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The impact of the COVID-19 pandemic upon patients, staff, and on the future practices of percutaneous coronary intervention

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The COVID pandemic in 2020 had unpredictable consequences on the presentation and management of patients with ischaemic heart disease. Subsequent to these initial responses the impact of the initial pandemic can be reviewed and responses can be considered. It is clear that there are new opportunities for optimising patient management pathways and in particular enhanced use of information technology. Changes in attitudes towards health and perceived risk are evident within both the catheter lab teams and our patient cohorts. Summating both the intellectual and emotional experiences of the pandemic are essential to prepare for either a second wave of COVID 19 or any new pandemic threat in the future.

The initial impact of coronavirus disease 2019

The initial impact of the coronavirus disease 2019 (COVID-19) pandemic within Europe began in Italy and these initial events have been well documented. Hospitals in northern Italy were flooded with cases of patients presenting with COVID-19-related symptoms and unfortunately, their local hospital services were unable to cope.[1] This led to doctors being unable to treat their patients optimally and pictures on the television news of patients lying in corridors. Italian doctors were interviewed reflecting on a lack of capacity and provision for patients and their lack of personal protective equipment (PPE). These news reports sent a shudder throughout healthcare systems worldwide. It was clear from an early stage that many patients with heart disease appeared to preferentially suffer more serious consequences from COVID-19 infection and that cardiac involvement was a common consequence of COVID-19 infection.[2–4] Presentation with symptoms and signs suggestive of acute ST-segment elevation myocardial infarction (STEMI) was rumoured to be frequent and catastrophic.[5]

As the virus began to progress initially through Spain, UK, and the rest of Europe, European interventional cardiologists found themselves preparing their services for these new challenges.[6] There was considerable confusion about the level of PPE that was required to treat patients with COVID-19 infection safely. The consequences of 'aerosol generation' in patients with acute infection were and are considered to be a crucial part of disease transmission within hospitals. Concern about the management of cardiac arrest with the requirement for cardiac resuscitation was raised as it was clear that patients presenting as an emergency could not be screened by nasal swabbing or a computed tomography (CT) scan to exclude active COVID-19 infection.

The discussion revealed that concern about cardiac arrest had already resulted in some services in China regress to delivery of thrombolysis as the initial management choice rather than mechanical treatment for patients with STEMI.[7] In many countries, official initial advice was contradictory about optimal protection for the catheterization laboratory (Cath lab) teams varying from standard sterility measures (single gown, single gloves, and standard surgical

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Table 1 The impact of COVID-19 outbreak on acute myocardial infarction admissions and catheterization

	Wilson *et al.*[8]	De Rosa *et al.*[9]	Solomon *et al.*[10]	Mafham *et al.*[11]	Piccolo *et al.*[12]	De Filippo *et al.*[13]	Rodríguez-Leor *et al.*[14]
Country	London, UK	Italy	NC, USA	England	Campania region, Italy	Northern Italy	Spain
Study design	Single-centre	Multicentre, observational	Multicentre, observational	Multicentre, observational	Multicentre, observational	Multicentre, observational	Multicentre, observational
Temporal window							
Pandemic period	19 February-14 April 2020	12 March-19 March 2020	04 March-14 April 2020	23 March-30 March 2020	27 February-26 March 2020	20 February-31 March 2020	16 March-22 March 2020
Non-pandemic period	The same weeks from 2017 to 2019	12 March-19 March 2019	05 March-15 April 2019	2019 weekly average	30 January-26 February 2020	20 February-31 March 2019	24 January-01 March 2020
AMI[a]	NA	−48.4%	−28%	−35%	NA	−27.7%	NA
STEMI[a]	−51.4%	−26.5%	−19%	−23%	NA	−22%	−40%
NSTEMI[a]	NA	−65.1%	−30%	−42%	NA	−43.3%	NA
P-PCI[a]	−42.8%	NA	NA	−21%	−32.5%	NA	−40%

AMI, acute myocardial infarction; COVID-19, coronavirus disease-2019; NA, not available; NSTEMI, non-ST-segment elevation myocardial infarction; P-PCI, primary percutaneous coronary intervention; STEMI, ST-segment elevation myocardial infarction.
[a]Laboratory activities: percent reduction between pandemic and non-pandemic period are presented.

mask) to Level 3 PPE used to treat patients suffering from Ebola virus (double gown, double gloves, face visor with either an MP3 mask or ventilator). A significant lack of availability of PPE contributed to the confusion and increasing anxiety within hospitals. Ultimately, however, by late March 2020, most interventional cardiology services had made their local preparations and braced themselves for the expected onslaught.[6]

What happened next was unexpected. Governments throughout Europe had initiated draconian lockdown measures to reduce case to case transmission within the community. Vivid images from Italy had made it evident to everyone within society that hospital services were at risk of collapse and explicit advice was given 'to stay away from hospitals unless it was absolutely necessary'. It was also clear to individuals that the most likely place to catch COVID-19 was within a hospital. The consequences of these dire warnings lead to dramatic and sustained reductions in presentation of patients to hospitals including patients with chest pain. The worrisome avoidance of medical care led to a substantial reduction of STEMI presentations which ranged from −20% to −50% during COVID-19 outbreak, associated with a greater decline of non-ST-segment elevation myocardial infarction (NSTEMI), as outlined in *Table 1*.[8–14] Furthermore, this reduction in health-seeking behaviour has been well established by Wilson *et al.*,[8] who demonstrated a three-fold increase of late-presenters patients with STEMI during the pandemic period. Besides these different temporal trends, a global reduction of primary percutaneous coronary intervention (PCI) rate for STEMI patients was documented up to −43% with respect to non-pandemic period (*Table 1*). Cardiac Cath lab services that had cancelled all elective work and been stripped down to expect a tsunami of emergency cases found themselves unoccupied for the first time in living memory.[15]

The second phase of the COVID-19 crisis: 'the new normal'

By May 2020, it had become clear that hospitals we are not going to be overwhelmed in most European cities. Many interventional cardiac services had accommodated and developed and moved into a phase that was coined 'the new normal'.[16] Although there were considerable numbers of patients with COVID-19 within hospitals, societal lockdown measures, and enhanced hospital provision had avoided a collapse of healthcare services. Urgent and emergency patients with coronary disease started to re-emerge along with cases of 'missed heart attack' presenting with mechanical complications,[17] such as ventricular septal rupture or acute ischaemic mitral regurgitation. Review of these patients' histories confirmed that patients had remained at home with chest pain during the 'eye of the storm' and had only come to hospital when they could bear their symptoms no longer.

The consequences of the change in management/clinical priorities were evident in particular areas. Firstly, there was a lack of availability of ventilators and intensive care. This had a particular impact on cardiac surgery and

elective surgical cases were effectively not possible and some stable patients were deferred. For those patients who needed urgent treatment and could not be deferred, interventional percutaneous options were pursued including multivessel coronary stenting[18] and/or percutaneous aortic valve implant. Discussion of individualized management strategies for these patients also required a new approach. Face to face meeting for multidisciplinary teams (MDTs) was advised against because of the risk of cross infection[19] and many heart teams began using computer technology including Microsoft Teams and Zoom. It soon became clear that these new IT platforms had a number of potential advantages especially the ability to allow ready viewing of angiographic, echocardiographic, and CT images in a universal format.

Treatment of patients presenting with acute myocardial infarction was made more complex by wearing the enhanced PPE. Wearing an extra gown and a visor together with lead coat protection resulted in inevitable perspiration with subsequent clouding of glasses and/or visors. This made viewing the angiographic screens difficult and consequently many operators chose to try and complete emergency cases as quickly and safely as possible. Once the culprit lesion treatment was complete, many operators favoured deferring non-culprit lesions and there was probably less acute use of intracoronary imaging. For patients presenting with acute coronary syndromes (ACS), some centres increased their use of non-invasive imaging in particular CT scanning. Reducing the duration of inpatient stay was an important priority both to clear beds for other patients and also to reduce the chances of patients contacting COVID-19 whilst an inpatient.

Many hospitals also had to review and change their methods of patient follow-up. It was simply not possible to bring patients to the outpatient department within the hospital both because of the challenge of travel but, in particular, the need for social distancing which reduced outpatient capacity. The use of telemedicine became almost routine overnight with telephone consultations and, in particular, computer-enhanced virtual consultations demonstrating immediate efficacy. Using the virtual clinic, a clinician could still undertake clinical review in a timely way with clear logistic advantages for clinicians/hospitals together with time savings in travel for patients.[20] One of the interesting consequences of these changes in the consultation environment and circumstances may have been a tendency towards more conservative medical therapy. Recent publication of the ISCHEMIA trial had suggested that revascularization in asymptomatic patients was probably of less benefit than many clinicians had predicted.[21] These data together with a reluctance to admit patients to hospital probably contributed to a reduction in elective revascularization.

Initial reflections on the COVID-19 pandemic and future impacts?

It is not yet possible to predict whether the onset of winter together with the recrudescence of winter flu and COVID-19 will herald a similar healthcare catastrophe in 2020–21. The potential availability of vaccines could have a profound impact and this together with society's attitude and tolerance of social distancing will presumably reduce the rates of virus transmission and subsequent clinical infection with COVID-19. However, it is possible to provide some initial reflections on the extraordinary preceding 6–9 months and perhaps speculate about some of the longer term consequences with relevance to the management of patients with coronary disease and our interventional cardiac practises (*Figure 1*).

(1) Healthcare systems must be prepared for future pandemics. Clear specific advice about how to limit in-hospital transmission and protect healthcare staff is crucial and within the cardiac Cath lab, this means more availability of appropriate PPE that can be worn comfortably without compromising practice.[6,22] It is particularly noteworthy that this pandemic has highlighted the personal healthcare risks that Cath lab teams take.[22] The risks of radiation exposure have probably been chronically under-emphasized and the risk of blood-borne viruses has almost been completely forgotten in many labs. An enhanced emphasis on protection of the Cath lab team is apparent and overdue. In the future, this might provide an opportunity for robotic and/or enhanced protective computer technology. Using current robotic technology even complex chronic occlusions can be treated by an operator controlling the wires and catheters seated at a joystick. Other team members are also protected from radiation as during the operative radiation screening, they are not required to be standing at the Cath lab table.

(2) Patients perceptions of risk have certainly been influenced by this crisis. There is a new acute awareness of the hazards associated with hospital admission and any hospital procedure. Hospital acquired infection has been a problem for many years particularly when it is associated with prostheses, but this has probably been downplayed and minimized. It seems likely that patients will have an enhanced awareness of the potential downsides of any procedures and that careful consent before embarking upon any interventional procedure will be even more important than ever.[23] These changing attitudes are likely to impact PCI practice. It is possible that patients may choose to persist with medical management when angina is manageable or minimal and for some patients with more complex disease coronary artery bypass surgery may no longer be appealing. Careful physiological assessment using pressure wire to determine which lesions need treatment may allow complete revascularization using coronary stents as an alternative. Data from the Syntax 2 trial are encouraging in this regard.[24] The predictability of procedures is probably at the heart of this debate and in this regard optimization of stent deployment is of critical importance. In more complex patients, the presence of potentially restrictive calcification

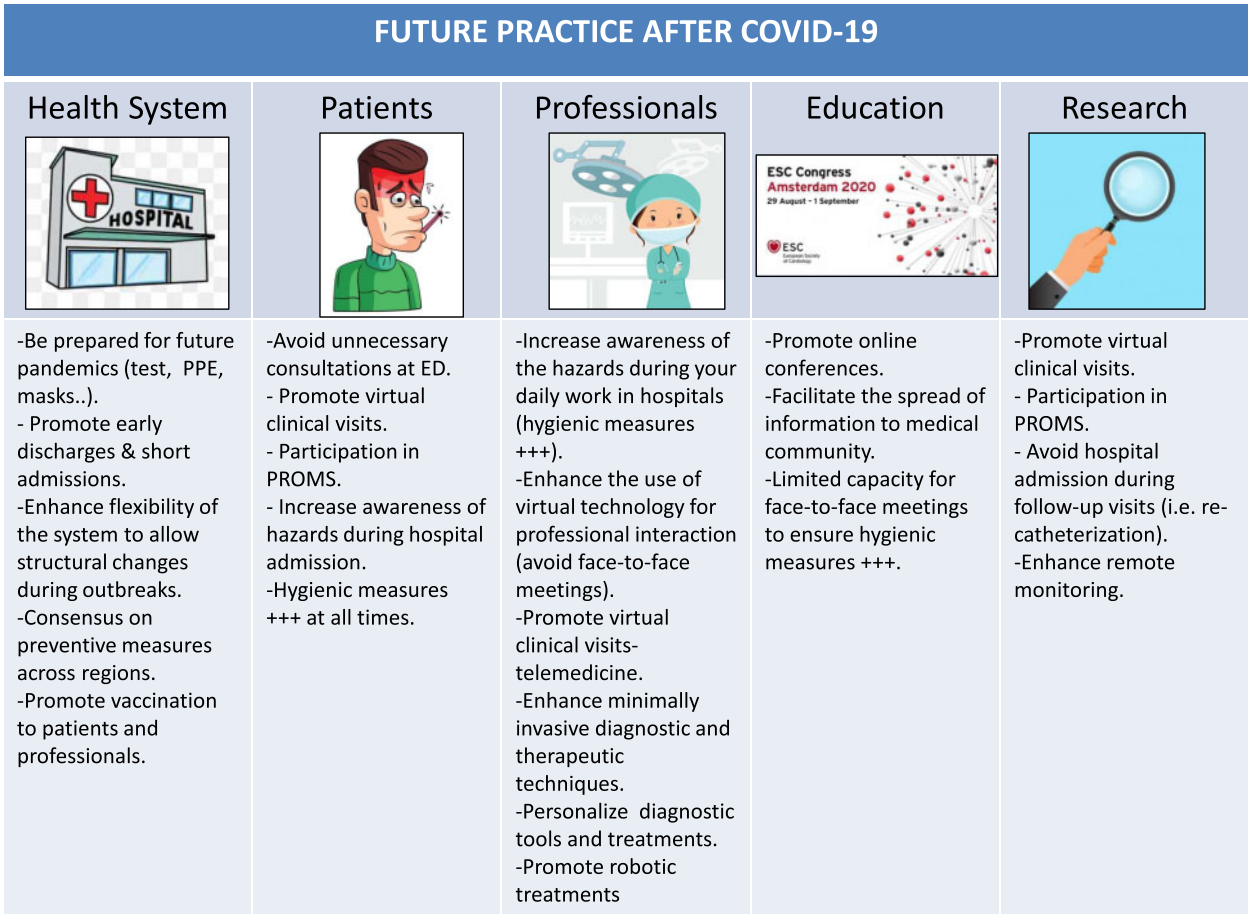

Figure 1 Future practices of percutaneous coronary intervention after COVID-19 outbreak. ED, emergency departments; PPE, personal protective equipment; PROMS, patient-recorded outcome measures.

enhances the need for intracoronary imaging. Ensuring that ischaemia has been abolished or at least minimized in the culprit territory by the completion of the interventional coronary procedure must surely be a clear objective. Although this seems an obvious expectation, it is not as predictable as many interventional cardiologists believe and further research and practise development are required to ensure this basic goal.

(3) The use of virtual conferencing technology may be one of the most obvious benefits of the pandemic to our clinical practises.[19] There is little doubt that the MDT/heart team can work extremely effectively in this virtual environment. It allows enhanced discussion between interventional cardiologists and cardiac surgeons both within the same hospital and perhaps more importantly between hospitals. It seems an achievable goal that personalized revascularization approaches optimally utilizing local expertise can result from this enhanced timely discussion. In many healthcare systems, there are unacceptable delays and long inpatient stays for ACS patients with angiographic evidence of multivessel disease. There are delays occur, while optimal management strategies are considered and then for subsequent transfer to be performed. Ensuring these delays are minimized by early discussion and/or completing preoperative assessment locally is likely to be of clear benefit to the patient and the hospitals.

(4) Using computer and mobile phone technology for patient consultation has the potential for considerable patient and economic benefit.[20] Virtual consultation can be time effective for the provider but importantly facilitate the patient's participation in their care.[22] This could be evident in simple factors, such as enhanced drug compliance but also potentially participation in PROMS (patient recorded outcome measures), clinical trials, and audit data collection. When one considers the potential of this technology, the historic standard of a follow-up in a clinic looks prosaic.

(5) Reducing the variability of care for interventional patients and increasing consistency of the approach to revascularization has been discussed for many years. Discussions between cardiac surgeons and interventional cardiologists about patients with multivessel coronary disease have occasionally been heated especially when it is considered that some patients might be better treated with multiple

stents rather than surgery. The provision of meaningful and respected international guidelines has an important role, but artificial intelligence and machine learning have huge potential. The ability of artificial intelligence to more accurately assess which of the observed coronary lesions are causing ischaemia and predict the outcome of revascularization is likely to become the standard in the future. It seems likely that CT scanning will become ubiquitous for patients with stable symptoms and experience during COVID-19 suggests more potential for CT in ACS too. Enhanced diagnostics before arriving in the Cath lab together with an agreed interventional management plan has the potential to reduce practice variability considerably. Most importantly, it may improve outcomes and then patient satisfaction, but it is also very likely to reduce cost.

(6) Finally, the COVID-19 crisis has also impacted dramatically on medical education within interventional practice, shedding lights on the potential of social media, such as Twitter.[25] On-line conferences have become the new standard and international conference travel has been minimal. It remains to be seen whether traditional 'pilgrimages' to large Congresses will re-emerge in 2021. If they do, one suspects that it will be with enhanced respect and understanding of the crucial role that friendship and interactive discussion has in the shared experience of professional life within interventional cardiology. Whether this can be duplicated by chatting on a computer screen has yet to be proven!

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